Department of Defense (DoD) SysML v2 Transition Guide Project Overview

INCOSE 2024 International Workshop

Daniel Hettema
Director, Digital Engineering, Modeling & Simulation
Office of Systems Engineering and Architecture
Office of the Under Secretary of Defense
for Research and Engineering

January 2024

Agenda

- DEM&S Overview
- Context for SysML v2 Transition Guidance
- How big is the change?
- SysML Transition Guidance
- Next Steps

Digital Engineering, Modeling & Simulation's Place in the Federal Government

SE&A
Systems Engineering & Architectures

DEM&S
DIGITAL ENGINEERING
MODELING AND SIMULATION

Joe Biden
President

Lloyd J. Austin III
Secretary of Defense

Heidi Shyu
Under Secretary of Defense (OUSD) for Research and Engineering (R&E)

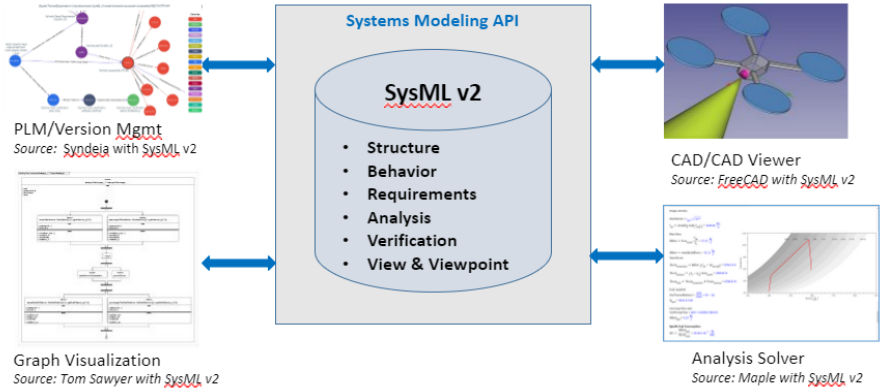
Tom Simms
Executive Director, SE&A

Daniel Hettema
Director

The Future of Systems Engineering Is Model-Based

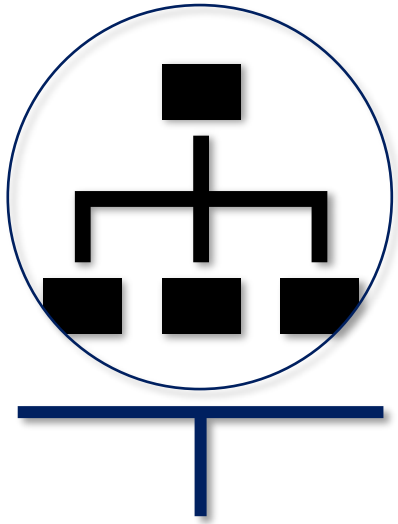
- Part of the digital transformation
- Full life cycle from SoS to component level
- Agile system development including automated workflow and Configuration Management of the digital thread
- Model patterns and reuse
- Facilitates:
  - The management of complexity & risk
  - More rapid response to change
  - Reuse and design evolution
  - Reasoning about & analysis of the system
  - Shared stakeholder understanding
  - Automated documentation & reporting

Source: INCOSE SE Vision 2035



Connecting SysML v2 through the API

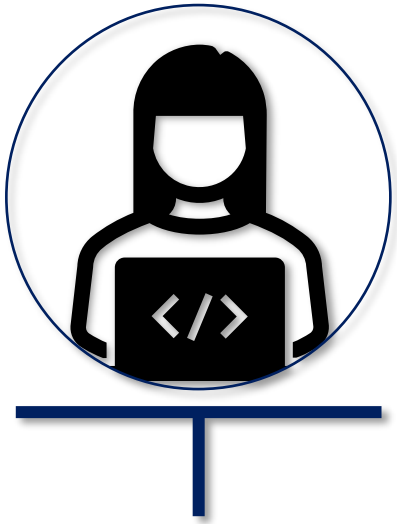
What is the scope of the change?



15,000 +

models in DoD

Based on sampling counts of government owned ecosystems



25%

DoD engineers use models

Based on reported data and user assumptions of those ecosystems

Size estimates do not include contractor ecosystem models and people using them

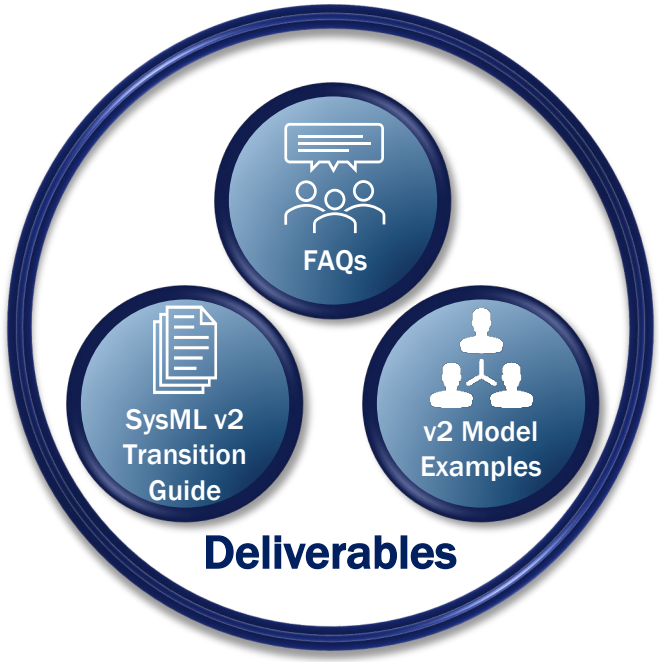
SysML v2 Transition Guidance

Guidance will:

- Address community questions and concerns on transition
- Define differences in syntax, semantics from v1 to v2
- Model examples that further explain guidance principles
- Provide stylistic suggestions to help streamline the modeling process
- Align transition and adoption effort
- Communicate the values of transitioning from v1 to v2

Outcomes:

- Greater transition success
- Faster transition
- Improve modeling practices and model quality
- Avoid duplications of effort
- Share lessons learned



Collaborating across the community

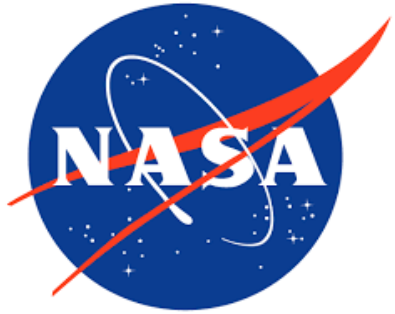
OMG Standards Development Organization

INL Idaho National Laboratory

DTO DIGITAL TRANSFORMATION OFFICE

DEVCOM ARMAMENTS CENTER

LOCKHEED MARTIN



MITRE

AEROSPACE

DASSAULT SYSTEMES

SYSTEMS ENGINEERING RESEARCH CENTER

How to Transition from SysML v1 to v2

Steps to transition from SysML v1 to SysML v2:

Derived from ChatGPT, 5/12/2023

- **Familiarize yourself with the changes:** New concepts, syntax, and semantics.
- **Identify the impacts:** Analyze the impacts of the changes in SysML v2 on your existing models, modeling tools, and processes.
- **Update your modeling tools:** Consider switching to a tool that support SysML v2.
- **Convert your existing models:** This may involve manual conversion or using automated tools, depending on the complexity of your models.
- **Update your processes:** This may involve changes in your modeling guidelines, templates, and reviews.
- **Retrain your team:** This may involve training on the new concepts, syntax, and semantics of SysML v2 and any new features in your modeling tools.
- **Plan for a gradual transition:** Gradually transition your existing models to SysML v2 as needed.
- **Communicate and Collaborate:** Collaborate with other stakeholders in your project to ensure they understand the changes and updates, and help them to adapt their processes, tools and methods to align with SysML v2.
- **Establish pilot projects:** Gather and align efforts towards transitioning to v2 and demonstrate initial implementation of a transition plan.

SysML v1 to v2 Transition Project Plan

				2022	2023				2024			
	WBS	Phase	Task Area	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	1	Phase 1: Transition Guidance										
	1.1		Outreach									
	1.1.6		NDIA 10/16/23					X				
	1.1.7		INCOSE IW 01/24						X			
	1.2		Establish SysML V2 Transition Team (STT)									
	1.3		SysML V1 to V2 Transition FAQ		D1	D2	R1	R2				
	1.4		SysML V1 to V2 Model Conversion Guidance				D1	R1	R2			
	1.5		Transition Plan Template					D1 D2	R1			
	1.6		SysML V2 Modeling Environment			D1	R1					
	1.7		SysML V2 Training (Flashlight Starter Model)					D1	D2 R1			
	1.8		Identify Other SysML V2 Transition Activities					D1	R1			
	1.9		SysML V1 to V2 Transition Guidance Website				D1		R1 R2			
	2	Phase 2: Organizational Transition (pilots)										
	3	Phase 3: Project Deployment										

Guidance Products

OMG MBSE WIKI

- Frequently Asked Questions (FAQ's)
- Transition Planning Guidance
- Tool Consideration Checklist
- Environment Installation Guidance
- Model Conversion Guidance
- Converted Model Examples
- Flashlight Starter Model

FAQ's

There are 52 questions and answers in these seven categories:

1. What is SysML v2 and how does it compare to SysML v1?
2. Why should a program and/or organization transition from SysML v1 to SysML v2?
3. When should a program and/or organization transition from SysML v1 to SysML v2?
4. Who is impacted by the transition from SysML v1 to SysML v2?
5. How does a program and/or organization or other stakeholder transition from SysML v1 to SysML v2?
6. What is the impact of the transition on a program and/or organization?
7. What are the mechanisms to access and provide SysML v2 guidance information?

Tool Criteria

- Based on tool conversion paper, 13 tool features were identified to support a v1 to v2 model conversion – here are some examples:
  - The Tool should show a comparison of the SysML v1 model against the SysML v2 model.
  - The Tool should id artifacts changed during transformation
  - The Tool should provide guidance on whether a model should be pre-processed or post processed.

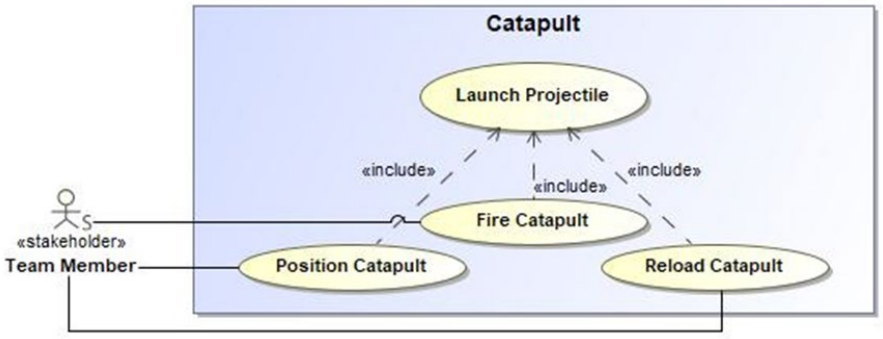
- 13 tool selection requirements are from chapter 18.5 of "A Practical Guide to SysML, The Systems Modeling Language", Third Edition
  - The Tool should be conformant to SysML v2.
  - The Tool should support availability of model libraries (e.g., units).

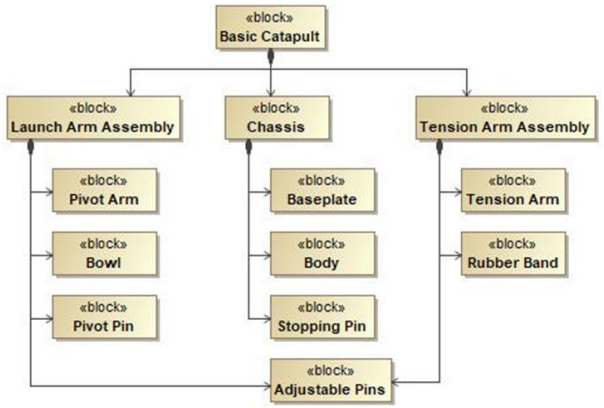
Set Up the Environment

- SysML V2 Kernel is publicly available now on SysML v2 Submission Team (SST) Git repository https://github.com/Systems-Modeling/SysML-v2-Release
  - Install is available for Eclipse and Jupyter Labs
  - Installation instructions available for Jupyter Labs on OMG Wiki
- To set this up in a Company network you will need to do more. Guidance we wrote can help.
- DoD practitioners can utilize ARCUS to install v2 environment.
  - We model here and are adding users.
- You may be able to use https://sysmlv2lab.com/

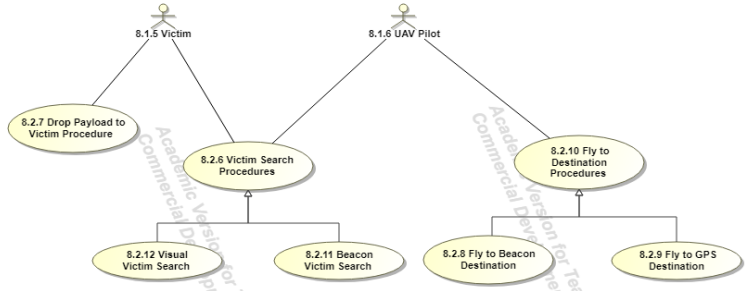
SysML v1 to SysML v2 Model Conversion

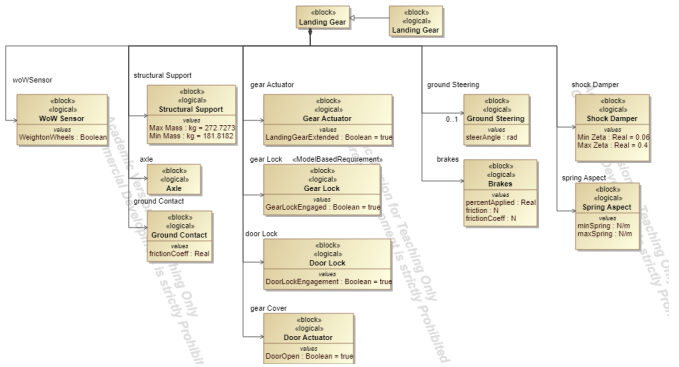
Armaments Catapult Model



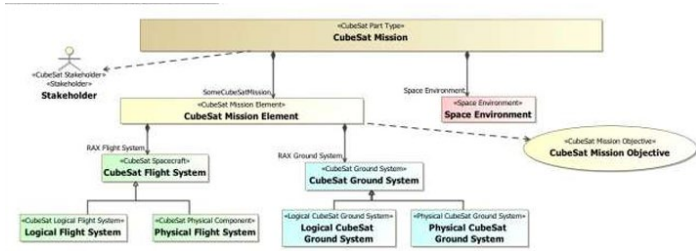


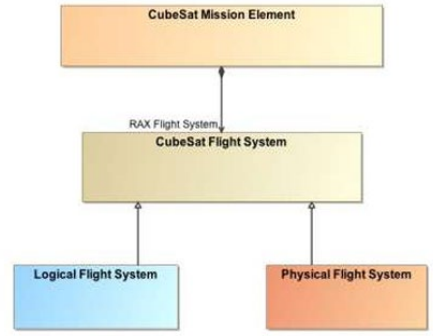
Skyzer Surrogate Pilot Model





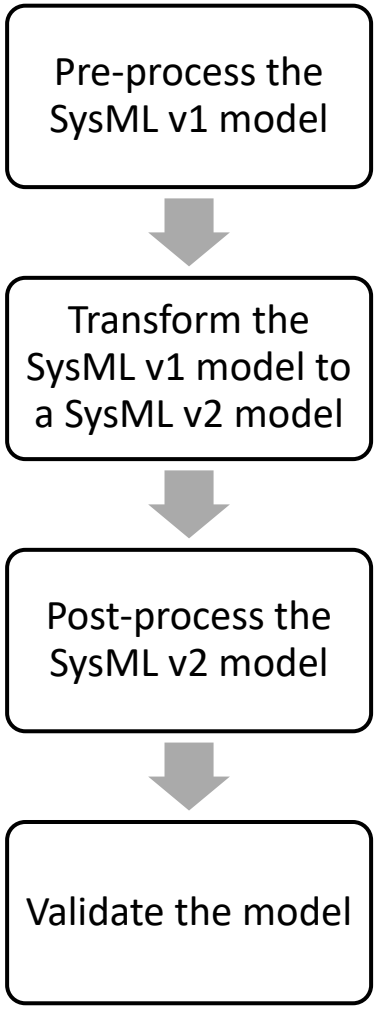
CubeSat Reference Model



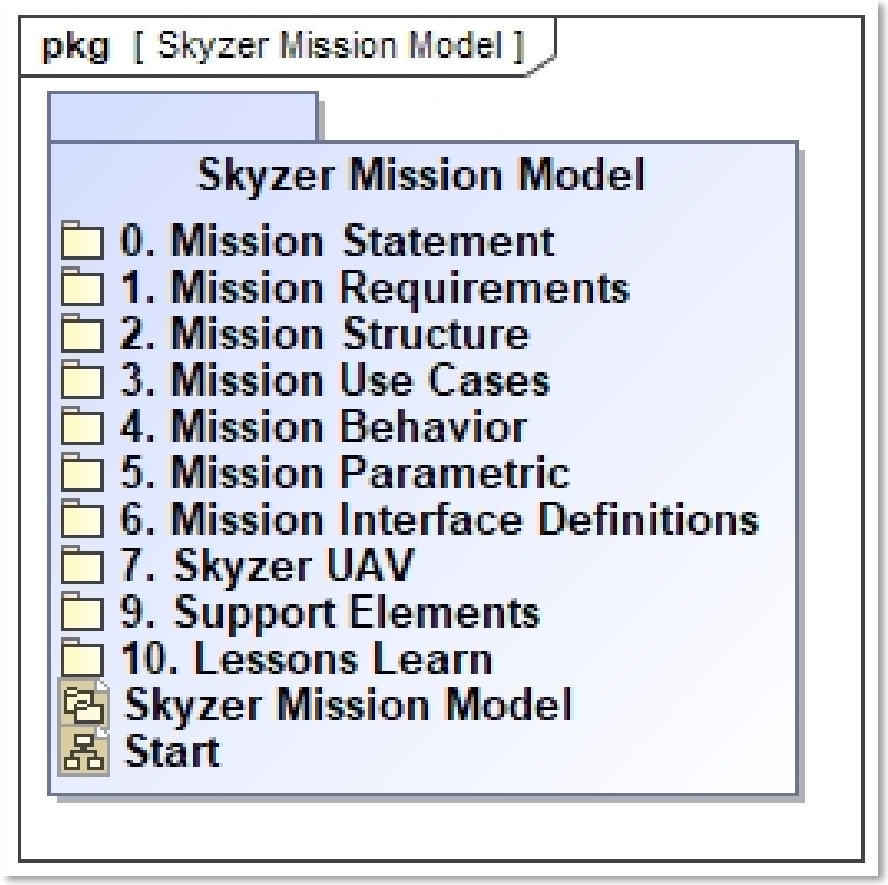


Model Conversion Process

1. Pre-process the SysML v1 model
   - Ensure model conforms to SysML v1 specification
   - May need to remove customizations, ensure model is well-formed, and adheres to standard guidelines (e.g., naming conventions)
2. Transform the SysML v1 model to a SysML v2 model
   - Tool automation executes standard transformation specification
3. Post-process the SysML v2 model
   - Reorganize, refactor, and refine model to leverage SysML v2 capabilities
4. Validate the model
   - Evaluate how well it satisfies model objectives and update as needed
5. Additional activities outside of the scope of the model conversion
   - Assess impact on SysML v1 derived artifacts
   - Regenerate the SysML v2 derived artifacts



Conversion Example – Package Structure



Skyzer SysML v1 Mission Model Package Structure

```
package SkyzerMissionModel_transformed{
    import '0.MissionStatement'::*;
    import '1.MissionRequirements'::*;
    import '2.MissionStructure'::*;
    import '3.MissionUseCases'::*;
    import '11.LanguageCustomization'::*;

    package '0.MissionStatement'{↔}
    package '1.MissionRequirements'{↔}
    package '2.MissionStructure'{↔}
    package '3.MissionUseCases'{↔}
    package '4.MissionBehavior'{↔}
    package '5.MissionParametric'{↔}
    package '6.MissionInterfaceDefinitions'{↔}
    package '7.SkyzerUAV'{↔}
    package '9.SupportElements'{↔}
    package '10.LessonsLearned'{↔}
    package '11.LanguageCustomization'{↔}
}
```

Skyzer SysML v2 Mission Model Package Structure

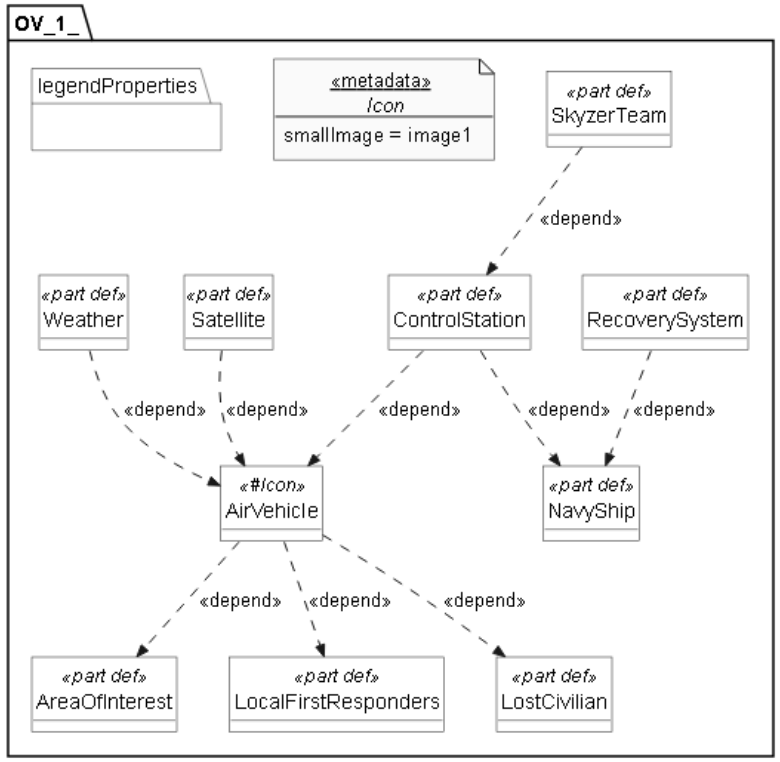
Conversion Example – Operational View

Skyzer SysML v1 Mission Model OV1 Diagram

```
package OV_1_{
    package legendProperties{
        // map to a rendering method
    }
    dependency from AirVehicle to AreaOfInterest;
    dependency from AirVehicle to LocalFirstResponders;
    dependency from AirVehicle to LostCivilian;
    dependency from ControlStation to AirVehicle;
    dependency from ControlStation to NavyShip;
    dependency from RecoverySystem to NavyShip;
    dependency from Satellite to AirVehicle;
    dependency from SkyzerTeam to ControlStation;
    dependency from Weather to AirVehicle;
    part def AirVehicle{
        @Icon{
            smallImage = image1;
        }
    }
    part def AreaOfInterest;
    part def LocalFirstResponders;
    part def LostCivilian;
    part def ControlStation;
    part def NavyShip;
    part def RecoverySystem;
    part def Satellite;
    part def SkyzerTeam;
    part def Weather;
}
```

OV1 Skyzer SysML v2 Mission Model

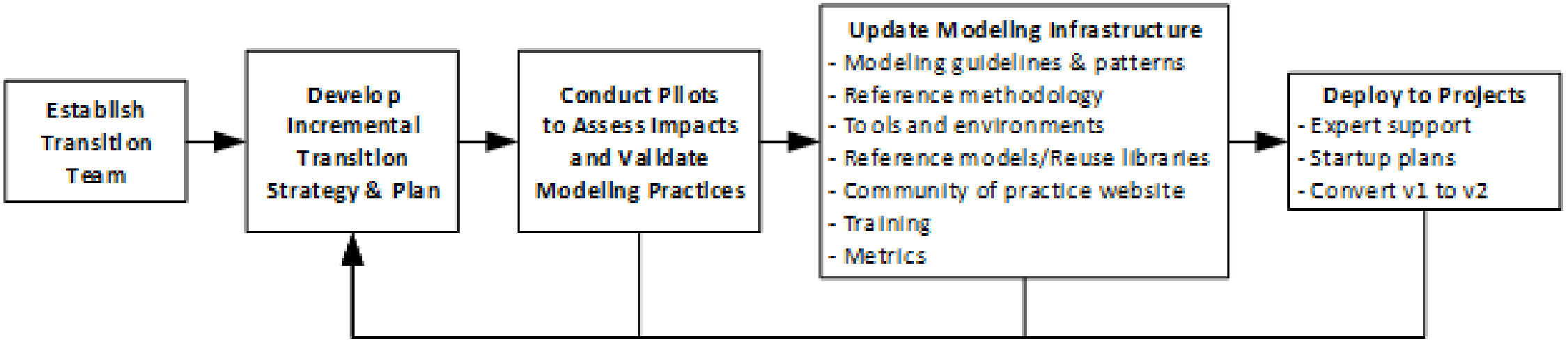
```
%viz --view tree --style comptree SkyzerModel_v2::SkyzerMissionModel_transformed::OV_1_
```



OV1 Skyzer SysML v2 Mission Model OV1 View

SysML v2 Transition Plan Template

SysML v2 Transition Approach



A Transition Planning workshop was held on October 16,2023

SysML v2 Transition Plan Summary of Outcomes

- **Establish the Team:** Establish a steering group and identify high-level official to endorse it in a carter. The membership should include S&T, PMO's and work level modelers. Recommend including contract and training personnel.
- **Transition Strategy and Plan:** Key elements include support resources, tool integration, and milestone achievements, aiming for successful outcomes and minimal disruption to program offices.
- **Transition Pilot Objectives:** Focus on achieving outcomes in transition pilots, Transition if v2 proves superior. Tailor limited-scope pilots to diverse stakeholders, emphasizing specific V2 capabilities. Establish pilots that aim to capture transition conditions, demonstrate benefits, and showcase v2 strengths.
- **Modeling Infrastructure:** Require v2, transition, and API training at various organizational levels. Define methodology, emphasizing CM and Data Management, and Agile synthesis. Completed trade studies for collaborative authoring in v2 tools are essential. Transition from widespread use of V1 tools to V2 tools. Incorporate v2 into the education pipeline and deployable tools approved for systems, collaborating with for software deployment.
- **Program Deployment Considerations:** Transition of Programs of Record to v2 based on lifecycle stage and readiness. Emphasizes risk reduction over benefits when promoting V2. Seek recommendations from acquisition and sustainment efforts, fostering open dialogue for effective SysML v2 adoption.
- **Opportunities for Improvement:** Focus on tracking progress, sharing lessons learned, and promoting collaboration. Emphasize integrating cost and trade studies, enhancing data tagging for improved science applications, and exploring cross-domain solutions. Highlights better support for data centricity, AI/ML, and standardized modeling for strong systems engineering foundations.

Distribution Statement A. Approved for public release: distribution is unlimited.

SysML v1 to SysML v2 Transition Working Session

When: Jan 30 **From:** 8 - 11 am PST

Where: Salon F

Agenda:

- Introduction – Frank Salvatore (10 min)
- Starter Model Overview and Walkthrough – Sanford Friedenthal (45 min)
- SysML v1 to SysML v2 Model Conversion Approach – S. Friedenthal (45 min)
- SysML v1.x to SysML v2 Model Conversion – Gene Shreve (30 min)
- Open Discussion – All (45 min)
- Wrap-up – Frank Salvatore (5 min)

Distribution Statement A. Approved for public release: distribution is unlimited.

Next Steps

- Continue work on transition guidance products
- Join our monthly community collaboration meetings
- Update products based on feedback
- Continue our outreach
- Plan Phase II

Please let us know of any outreach opportunities

Contact Info

Office of the Under Secretary of Defense for Research and Engineering

Systems Engineering and Architecture

osd-sea@mail.mil | Attn: DEM&S

https://www.cto.mil/sea/dems